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SEVENTY-FOURTH

ANNUAL REPORT

OF THE

DIRECTOR

OF

THE ASTRONOMICAL OBSERVATORY

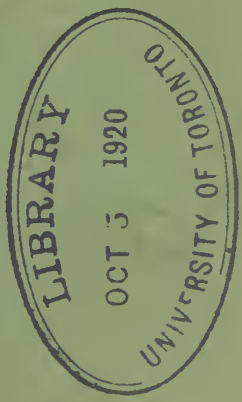
OF

HARVARD COLLEGE

FOR THE YEAR ENDING SEPTEMBER 30, 1919

BY

S. I. BAILEY



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THE OBSERVATORY

To the President of the University: —

Sir, — The Astronomical Observatory has suffered an irreparable loss during the past year through the death, on February 3, of Edward Charles Pickering, for forty-two years its Director. Under his control, the Observatory became "preëminent in America, and in certain fields leader of the world," and he came to be regarded as "The Dean of American Astronomy." Outlines of his life and work have been published in many scientific journals.

Notwithstanding the energy and promptness with which observations were prepared for publication under his superintendence, a large amount of material remains, which is practically ready for the printer, but which cannot be published as rapidly as is desirable for want of funds. The demand for the six remaining volumes of the Henry Draper Catalogue is insistent, and provision should soon be made for three additional volumes of Kapteyn's "Selected Areas." Several other volumes of miscellaneous astronomical researches and meteorological observations are also ready for printing. The prompt publication of all this material is necessary in order to complete worthily the great life work of the late Director. This would require, owing to the increased cost of printing, a sum of about fifteen thousand dollars, in addition to the regular income of the Observatory.

An attempt has been made during the year to render more systematic and effective the photographic survey of the Milky Way for the discovery of Novae and other interesting objects. The plan includes the prompt examination of photographs of small scale made both at Cambridge and Arequipa, in order to establish definitely, through a limited period, perhaps, the number of such new stars above a certain magnitude. Their discovery hitherto has been largely a matter of chance, and in general confined to naked-eye stars. The present investigation extends to the ninth magnitude. New stars, so far as known, occur only in or near the Milky Way. Two new stars have been thus discovered, one by Miss Joan C. Mackie and one by Miss Ida E. Woods, in addition to a number of new variables.

The two astronomical fellowships for women have been filled by Miss Dorothy W. Block and Miss Mary D. Applegate. Toward the end of the year, Miss Block was called to a position at the Yerkes Observatory, and the fellowship was assigned to Miss Antonia C. Maury, who is engaged in a study of the spectroscopic binaries discovered at this Observatory.

Dr. Joel H. Metcalf, during his summer vacation at South Hero, Vermont, made a remarkable record by the independent discovery of three comets within two days, with a telescope made by himself. One of these comets had been observed several days earlier in Europe, and another is probably Brorsen's Comet of 1847, whose rediscovery at this time is an event of unusual interest.

Henry Draper Memorial

The publication of the Henry Draper Catalogue has made steady progress. Three volumes have now been issued. Of the remaining six, one is in type and the other volumes can be made ready for the printer as rapidly as the necessary funds are available. Miss Cannon, in addition to supervising the publication of this Catalogue, has completed investigations regarding the spectrum of Nova Aquilae, No. 3, stars of composite spectra, and spectra of the variable stars of long period. She is also engaged in a study of the spectra of red stars.

The photographic observations at Cambridge remain under the direction of Professor King. The total number of plates exposed at Cambridge was 5,166, of which 4,700 were photographs of the stars. The number of successful plates made with the 16-inch Metcalf Telescope for the position of the Moon was 79.

Measures for the determination of the light of the sky have been continued, using both blue and yellow light.

The discussion of the work already done in obtaining photovisual magnitudes of stars and planets by the out-of-focus method has been completed. The paper includes the determination of the color index, not only of the bright planets but also of Nova Aquilae, No. 3. Similar work has been begun on a more extended list.

A new method has been devised of converting sidereal to Greenwich mean time, expressed in thousandths of a day, corresponding to the middle time of exposure. By this method, the speed of reduction is more than doubled.

Boyden Department

The Arequipa Station has been under the charge of Mr. F. E. Hinkley, who has been assisted by Señor J. E. Muñiz. The 10-inch Metcalf Telescope has been employed in making the plates in blue and yellow light necessary for the extension of photographic and photovisual magnitudes to the southern stars. Considerable work has also been accomplished with the Bruce 24-inch and the Boyden 13-inch Telescopes, as well as with smaller instruments. The whole number of plates made at Arequipa during the year was 3,308.

The Mandeville Station in Jamaica has continued under the direction of Professor W. H. Pickering, who reports that the regular observations of the ellipticities and position angles of the elongated disks of Jupiter's four larger satellites have been maintained. Special studies have been made of the seasonal changes occurring in the lunar crater Eratosthenes, consisting mainly of the development of the various fields and canals, and the shifting location of the latter. An investigation of the numerous small snow fields lying near Conon has been undertaken, and the usual dates of appearance and disappearance of each have been determined.

While the evidence is against the duplication of the canals of Mars, and each of the observers this past year has expressed the view that the appearance was simply an illusion, yet oddly enough certain of the canals occurring in the snow craters of the Moon are either really double, or else appear to be so by contrast with the snow. The widest and most clearly marked parallel pair so far detected lie in a craterlet on the rim of Posidonius, its breadth being 0″.6 or about 3,600 feet. It is only double near the full, and its duplication is without doubt the most difficult test for definition yet investigated upon the Moon.

Only one Report was issued this year on the observations of the International Associated Observers of Mars. As many as twenty-five well-known canals were seen by at least six observers, and eighty-three were seen by as many as two. Some of the latter were very difficult, and only temporary. The chief ones have been found to shift over the surface, in a manner agreeing with predictions previously published. The positions of twenty-six lakes were determined, and confirmed by at least two observers.

Blue Hill Meteorological Observatory

The observational and routine work of the Observatory has been carried on without a break. Records covering a period of thirty-four years are now available for the elements of pressure, temperature, humidity, precipitation, sunshine, day and night cloudiness, wind direction and velocity. The data for the civil year 1918 have been published in the usual form in H.A. **83**, Part **3**. There were no special papers published, but material is now available for memoirs on cloud measurements, humidity, and wind velocities at flying levels.

Several new instruments have been devised, one in particular, an absolute humidity recorder which should prove a valuable instrument in astronomical observatories, since it gives a continuous record of actual and sensible temperatures and both relative and absolute humidities. Such instruments in the dome of an observatory might help to throw light on some of the questions connected with good seeing.

Photographic Magnitudes

This work has continued under the direction of Miss Leavitt. The 16-inch Metcalf Telescope continues to be used for plates, taken in series, which give the means of comparing all parts of the sky, visible in Cambridge, with the North Pole. The 10-inch Metcalf Telescope has been used in Arequipa for similar work, replacing the 8-inch Bache Telescope. All parts of the southern sky are compared with Harvard Standard Regions having centres at the declination $+15°$. Both instruments are equipped with diffraction gratings, giving an independent measure of the scale of magnitudes. The measurement of sequences on series plates has been practically completed for the fifty Harvard Standard Regions with blue and with yellow light, for the 252 Selected and Special Areas of Kapteyn with blue light, for the 216 selected regions in overlapping zones of the Carte du Ciel with blue light, and for many special objects with blue and with yellow light. Measures for catalogues of stars brighter than the eleventh magnitude in regions four degrees square have been completed for each of the thirty-six Harvard Standard Regions north of the equator. Two plates with blue and two with yellow light are measured for each region. These will give photographic and photovisual magnitudes for about 11,000 stars. A beginning has been made on simi-

lar catalogues for regions south of the equator. The determination of the magnitudes of comparison stars for variables and the study of their light curves continue to be important features of the work of this department. Many requests for information concerning new or suspected variables have been answered. Owing to conditions brought about by the war, the number of assistants has been reduced, and the volume of observations is somewhat smaller than that reported last year. They include about 50,000 measures of the brightness of stars in sequences and catalogues, about 24,000 estimates of the brightness of Novae and variables, and about 3,500 measures of the brightness of asteroids. A card catalogue which will contain information regarding every star whose magnitude is determined from the photographs is in preparation. The whole number of stars whose magnitudes have been derived from two or more blue plates is now in the neighborhood of 30,000.

Variable Stars

Systematic visual observations of variable stars have been continued by Mr. Leon Campbell, who also has supervised the observations received from the members of the American Association of Variable Star Observers, and others in foreign countries. Professor Mitchell, Director of the McCormick Observatory, Professor Wilson, of the Goodsell Observatory, and Professor Parkhurst, of the Yerkes Observatory, by their coöperation with large telescopes, have furnished much needed magnitudes of faint variables near minimum. The light curves derived from all these observations are more complete than ever before.

Mr. Campbell has attempted, also, to follow the variables with the 15-inch Telescope, when too faint to be observed with smaller instruments, or when other observations were lacking. With the photometers attached to the 12-inch and 15-inch Telescopes, he has secured 8,474 settings, of which 3,680 were of Algol and short period variables, 1,872 of the minor planets for evidence of variability, 1,152 of the long period variables, and 546 of Nova Aquilae, No. 3. A discussion of the light curve of this new star is in process of publication. For it, 6,137 observations were received from 240 observers in 29 countries.

The discussion of the observations of long period variables for the years 1905 to 1917, inclusive, is well advanced. For this purpose, Mr. C. L. Brook, Secretary of the Variable Star Section of the British Astronomical Association, has furnished much valuable

material. In all, 16,941 visual observations have been made or received here, distributed as follows: —

F. C. Butterworth, 1,427; W. J. Luyten, 1,236; C. Y. McAteer, 1,208; J. F. Skjellerup, 1,125; L. Campbell, 1,016; T. C. H. Bouton, 838; J. M. Baldwin, 792; A. W. Long, 782; B. H. Dawson, 775; McCormick Observatory, 745; L. C. Peltier, 590; H. C. Bancroft, Jr., 587; Ed. de Perrot, 514; N. Tapia, 506; D. B. Pickering, 495; H. C. Wilson, 445; A. S. Young, 438; Ed. de Janczewski, 367; C. S. Mundt, 333; S. C. Hunter, 268; C. T. Whitehorn, 245; G. Houdard, 238; H. W. Vrooman, 209; I. L. Murray, 150; B. Berloty, 109; G. B. Lacchini, 105; H. Thomson, 103. Besides these, 1,390 observations were communicated by 46 observers, each of whom made less than 100 estimates.

About four hundred photographic charts of variable star regions have been furnished to observers, chiefly in the southern hemisphere. All descriptive data are now marked on enlarged negatives, so that paper prints made from them are ready for the observer without additional marking. This work has been done for the most part by Miss Mabel A. Gill, and will be the means of saving considerable labor in the future.

Mr. Howard Eaton, a graduate student of the University, has undertaken the photometric determination of new sequences for additional variable stars. His work is that of a volunteer observer.

The study of globular clusters has been extended by the aid of Miss Woods, who has found two open clusters to be rich in variables, N. G. C. 3201 and N. G. C. 6362. They contain fifty-six and fifteen variable stars, respectively. Very few globular clusters now remain in which stars brighter than the sixteenth magnitude have not been examined.

Miscellaneous

Phillips Library. — The Library has increased during the year by the addition of 609 volumes and pamphlets, making the total number at the present time 56,316.

Telegraphic Announcements. — Nineteen announcements of astronomical discoveries have been sent to Europe and South America. Code messages, which were not permitted during the war, are again in use. Cablegrams addressed to "Observatory, Boston," and telegrams to "Harvard College Observatory, Cambridge, Mass.," are given all desired distribution in this country and abroad.

Twenty-five Bulletins have been issued, making 694, in all. These Bulletins supplement the cablegrams and telegrams, but contain much additional information. Telegrams are sent at cost to subscribers, who receive the Bulletins without extra expense.

Publications. — The following Annals have been issued during the year: — **78**, Part **3**, Variable Stars in the Cluster Messier 15; **81**, No. **1**, Proper Motions of Stars in the Zone $-9°\,50'$ to $-14°\,10'$; **82**, No. **1**, The Harvard Station in Jamaica; **82**, No. **2**, Measurement of Close Double Stars with a Small Telescope; **83**, No. **3**, Observations and Investigations made at the Blue Hill Meteorological Observatory in the year 1918; **85**, No. **1**, Standards of Magnitude for the Astrographic Catalogue; **92**, The Henry Draper Catalogue, 4^h, 5^h, and 6^h; **93**, The Henry Draper Catalogue, 7^h and 8^h. Printing has been begun on several other volumes of the Annals, and, as indicated at the beginning of this report, about twelve volumes are nearly or quite ready for the printer. Nine circulars have been published during the year, as follows: —

211. Globular Clusters. October 31, 1918.
212. Maxima in 1919 of Variable Stars of Long Period. November 6, 1918.
213. Publications issued in 1918. January 1, 1919.
214. Astronomical Fellowships for Women. March 29, 1919.
215. Perturbation of Neptune. May 1, 1919.
216. Variable Stars in the Cluster N. G. C. 3201. May 24, 1919.
217. Variable Stars in the Cluster N. G. C. 6362. June 24, 1919.
218. 10 New Variable Stars in Harvard Maps 25 and 28. August 14, 1919.
219. 200317. Nova Sagittae. H. V. 3518. September 18, 1919.

S. I. BAILEY, *Acting Director.*

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